REMARKS

The Examiner has not acknowledged Applicants' claim for foreign priority. Applicants respectfully request that the Examiner make such acknowledgement in the Examiner's next communication.

The Examiner has not returned signed copies of Forms PTO/SB/08 A&B filed with Applicants' Information Disclosure Statements of December 10, 1999, and August 2, 2000. Applicants respectfully request that the Examiner initial and date the Forms, and return signed copies to the undersigned in the Examiner's next communication.

Claims 1-76, 79, 82-85, 87 and 88 are all the claims pending in the application.

At page 2 of the Office Action, Claims 76, 79, 81-85 and 87 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Gratzel et al. (US 4,847,231), optionally in view of Bankmann et al. (US 5,387,726) or Umemura et al (US 4,177,161).

Applicants respectfully traverse the rejection for at least the following reasons.

Applicants wish to point out that Claim 81 has been canceled in the Amendment Under 37 C.F.R. § 1.111, previously filed on July 17, 2002.

Applicants wish to emphasize that the content of the OH group is a content of that chemically bonded to TiO_2 used as a carrier, that is, before the ruthenium compound is formed thereon.

None of the cited references disclose or suggest the presently claimed range of the content of the OH group chemically bonded to TiO_2.

The OH group content in the TiO_2 carrier usually depends on the method of producing titanium oxide. The chemically bonded OH group cannot be formed by simple wetting,

namely, when titanium oxide is wetted with water, the content of the OH group chemically bonded does not change.

In the ordinary method for preparing TiO_2, the TiO_2 contains OH groups in a small amount because anatase TiO_2 is converted into rutile TiO_2 at a temperature higher than that at which OH groups are removed from TiO_2. Specifically, when titanium oxide is heated to a high temperature, such as 700°C (Bankmann et al.) or 900°C or above (Umemura et al.) to convert anatase TiO_2 into rutile TiO_2, the content of the OH group chemically bound begins to decrease due to dissociation of the OH group from TiO_2 by dehydration as H_2O.

Specifically, Umemura et al. discloses use of rutile titanium dioxide as a support of a catalyst. Further, Umemura et al. discloses that the rutile titanium dioxide is obtained by calcining anatase titanium dioxide containing a vanadium compound at 650 to 1500°C. Particularly, when a vanadium containing compound is not present, the calcination temperature is approximately 900°C or more (column 3, lines 3 to 34, particularly lines 26-29).

As explained above, at a temperature as high as 900°C, the OH group is dissociated from titanium oxide. For this reason, Applicants respectfully submit that in Umemura et al., the amount of the OH group chemically bound to the rutile titanium oxide is lower than that in the presently claimed invention. Further, Umemura et al. is silent on the amount of the OH group chemically bound to titanium dioxide.

Applicants also respectfully submit that in Bankmann, the OH group is also dissociated from TiO_2 at 700°C for the reason mentioned above.

In contrast, TiO_2 having a relatively high content of OH groups as in the present claimed invention is prepared by a method different from the ordinary method wherein

calcination at a high temperature is not required. Accordingly, TiO_2 of the present invention is different from the rutile TiO_2 of Gratzel.

Applicants respectfully submit again that catalytic activity depends on the amount of OH group bound to Ti of TiO_2 used as a raw material for preparing the catalyst. Therefore, the difference of the catalytic activity shows that the structures of the catalyst are different from each other.

In an article co-authored by one of the inventors of the '231 Patent (Gratzel), Mat. Ses. Soc. Symp. Proc., Vol. 139, pp. 373 (1989) which was submitted in the IDS filed April 5, 1999, data was reported concerning catalyst in which RuO_x is supported on TiO_2. In connection with that article, particles of RuOx were formed on TiO_2 of 100% rutile form or of a mixture of the rutile and anatase forms as shown in electronic microscope photographs. Applicants respectfully submit that, because the '231 Patent is very unclear with respect to preparation of the catalyst, it is appropriate to refer to this article.

In contrast, as mentioned in Applicants' previous responses, it is clear that RuO_2/rutile TiO_2 catalyst in accordance with the claimed invention, in which RuO_2 particles are not observed on a rutile TiO_2 carrier (as shown in a photograph in the Second Declaration filed August 13, 2000), can be obtained by supporting RuO_2 on rutile TiO_2 having a high OH group content.

Therefore, with reference to the above-mentioned article, which Applicants believe is appropriate, it is clear that the catalyst of the claimed invention is different from the catalyst disclosed in Gratzel.

It should also be noted that in the abstract of this article, it is indicated that the metal particles are selectively dispersed on the TiO_2 crystallites with the rutile structure. Thus, it is clear that the RuO_2 is dispersed on the rutile TiO_2.

This means that the supported RuO_2 cannot be highly dispersed since the amount of OH groups on the TiO_2 is too small. This is demonstrated in Examples 8 and 17 in the specification of the present application. As a result, as shown in the article (page 329, Fig. 1b), the image of RuO_2 particles is observed in the electron microscope photograph.

Namely, this difference in the catalytic activities is caused by the difference of the amount of OH group bound to Ti of the TiO_2 used as a raw material for preparing the catalyst, even if the amount of OH group contained in the catalyst as a final product is the same as that contained in another catalyst prepared by using TiO_2 (rutile 100%) having a different amount of OH content in the TiO_2 used for preparing the catalyst. (It is actually impossible to measure the OH content in the catalyst as the final product.) The structures are different from each other because the catalytic activities are different from each other.

In view of the above, Applicants respectfully submit that the catalyst of the claimed invention is different from the catalyst disclosed in Gratzel.

To further demonstrate the dependency of the amount of the OH group in the TiO_2 carrier on the catalytic activity of the catalyst (final product), Applicants herewith submit another Declaration pursuant to 37 C.F.R. § 1.132 executed by Mr. Takuo HiBi, a co-inventor of the present invention.

Specifically, in the present Declaration, a catalyst (Experiment) was prepared in a similar manner as in Example 5 of the present specification using a titanium oxide powder

PT-101. The content of the OH group chemically bound to TiO_2 of Experiment was determined to be 1.69 $X10^{-4}$ mol/g-carrier.

The catalytic activity of Experiment, i.e., chlorine formation per unit weight of the catalyst, was determined in the same manner as in Example 5 of the present specification, and the results along with those of Examples 5, 14 and 15 of the present specification were depicted in the figure.

The contents of ruthenium contained in the catalysts of Examples 5, 14 and 15 of the present specification were 4.7% by weight, and that of Experiment was 4.8% by weight. Applicants submit that all of the contents are essentially same. Further, the rutile content of titanium oxide used as a carrier in each of these catalysts is 100%. In this regard, Applicants wish to point out that TiO_2 used in the Examples of Gratzel et al. is P25 powder (a mixture of 80% anatase and 20% rutile), which is not included in the presently claimed invention. The contents of the OH group chemically bound to TiO_2 in Examples 5, 14 and 15 were 8.5 x 10^{-4}, 6.0 x 10^{-4} and 3.7 x 10^{-4}, respectively.

As clearly shown in the figure, Experiment, Examples 5, 14 and 15 each having a different content of the OH group of TiO_2 used as a carrier, have different catalytic activities.

That is, the amount of the OH group contained in the titanium oxide carrier used for the ruthenium catalyst affects the activity of the catalyst on chlorine production. Therefore, the structure of the catalyst varies depending on the amount of the OH group of TiO_2 used as a carrier.

Further, Applicants respectfully submit that the present invention provides unexpected superior results. In addition to the two previously submitted Declarations, it is apparent from the figure in the present Declaration, that Examples 5, 14 and 15 wherein the amounts of the

OH group of TiO_2 used as a carrier fall within the presently claimed range of 3.0×10^{-4} to 10.0×10^{-4} mol/g have higher activity than Experiment wherein the amounts of the OH group is 1.69×10^{-4} mol/g. This effect cannot be expected in light of the disclosure of Gratzel et al., optionally in view of Bankmann et al or Umemura et al.

In view of the above, Applicants respectfully submit that the present invention is not obvious over the cited reference. Accordingly, the Examiner is respectfully requested to reconsider and withdraw the rejection.

At page 4 of the Office Action, Claims 76, 79, 81-85 and 87 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Buysch et al (US 6,001,768), optionally in view of Bankmann et al (US 5,387,726) or Umemura et al (US 4,177,161).

Applicants respectfully traverse the rejection for at least the following reasons.

Applicants wish to point out that Claim 81 has been canceled in the Amendment Under 37 C.F.R. § 1.111 previously filed on July 17, 2002.

Buysch discloses use of rutile TiO_2 as the Examiner pointed out. However, Buysch fails to teach or suggest not only the amount of OH group chemically bound to TiO_2 used as a carrier, but also the dependency of the catalytic activity on the amount of OH group.

In contrast, as shown in the present Declaration, the catalyst having the presently claimed range of the amount of the OH group chemically bound to titanium dioxide has unexpectedly superior activity.

Further, as set forth above, Bankmann et al and Umemura et al do not rectify the deficiencies of Buysch.

In view of the above, Applicants respectfully submit that the present invention is not obvious over the cited reference. Accordingly, the Examiner is respectfully requested to reconsider and withdraw the rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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